Atomic Energy Control Board
P.O. Box 1046
Ottawa, Canada
K1P 5S9

Commission de contrôle de l'énergie atomique
C.P. 1046
Ottawa, Canada
K1P 5S9

INFO-0311

AECB STAFF ANNUAL REPORT OF BRUCE NGS'B' FOR THE YEAR 1988

by

AECB STAFF

May 1989

Canada

Report

TABLE OF CONTENTS

1. INTRODUCTION

2. STATION OPERATION

3. AECB STAFF REVIEW OF OPERATIONAL SAFETY ASPECTS

3.1 Station Compliance
3.2 Quarterly Reports
3.3 Radiation Protection
3.4 Station Effluents and Environmental Monitoring
3.5 Process Systems
3.6 Performance of Special Safety Systems
3.7 Significant Events
3.8 Quality Assurance
3.9 Station Maintenance
3.10 Chemistry
3.11 Station Management
3.12 Training
3.13 Emergency Exercises and Drills
3.14 Security
3.15 AECB Staff Inspections
3.16 Measures of Station Performance

4. SIGNIFICANT LICENSING MATTERS AND ACTIVITIES

4.1 Containment Test
4.2 EFADS Commissioning
4.3 Station Complement
4.4 Station Organization
4.5 Moderator Pipe Break Assessment

5. CONCLUSIONS

APPENDIX A - Reportable Significant Events

APPENDIX B - Objective Measures of Station Performance

1. INTRODUCTION

The operation of the Bruce "B" Nuclear Generating Station is monitored and licensing requirements are enforced by the AECB Bruce project staff, with appropriate support from other AECB personnel. The staff observes operation of the reactors, conducts audits, witnesses important activities, reviews station documentation and reports, and issues approvals where appropriate in accordance with licence conditions.

As required by a condition of its Operating Licence, Ontario Hydro, each year, submits Technical Reports which summarize various aspects of the operation of Bruce NGS"B" during the year. When these reports have been reviewed by AECB staff, a formal Annual Review Meeting is held with the station management to discuss safety-related aspects of the station operation, and to inform Ontario Hydro of AECB staff conclusions with respect to the performance of Ontario Hydro in operating the station during the year.

The purpose of this report is to summarize and record the conclusions of the AECB staff assessment of the operation of Bruce NGS"B" during 1988.

2. STATION OPERATION

Objective measures of station performance have been tabulated and may be found as Appendix 1. For further detail, the Quarterly Technical Reports, produced by Ontario Hydro should also be consulted.

After uprating to 100% power, units 5 and 7 had new maximum continuous ratings of 915 MWe established during 1988. The maximum continuous rating for units 6 and 8 is still 890 MWe. These units will undergo modifications for uprating during their next warranty outage. The overall station capacity factor for 1988 was 79.4%. This is lower than past years, the principal reason being the four-unit outage taken during the second quarter to test the containment system. This outage was extended past the test to install water deflectors over two vacuum ducts in the vacuum building.

3. AECB STAFF REVIEW OF OPERATIONAL SAFETY ASPECTS

3.1 Station Compliance

During 1988 there was one violation of the Radioactive Transport Licence. On 88-07-06 and 88-07-13, cobalt shipments of 4 flasks each were made to AECL where the activity of each flask exceeded the certificate (CND/2047/B(U) Rev.2) limit of 400,000 Ci by 20 - 27%. The root cause of the violation appears to be an error made to some of the input used by the computer program used to calculate the amount of cobalt activity. While Ontario Hydro is confident that this error will not recur, AECB staff is still questioning the quality control of the computer software and input. Ontario Hydro has also taken the step of purchasing a gamma monitor to physically measure the activity of each cobalt bundle prior to loading it into the cobalt flask.

Other than this, Ontario Hydro, in general, complied with the operating licence and regulations during 1988. There were, however, some events, discussed in other sections of this report, which could be interpreted as not complying with the intent of the Operating Policies and Principles.

3.2 Quarterly Reports

Quarterly technical reports for 1988 have been submitted by Ontario Hydro in a timely manner. These reports have been reviewed by AECB staff and were the main source of data for the table of Objective Measures in Appendix 1.

At AECB staff request, a new section on safety system fault reclassification has been added to the quarterly reports (as of the fourth quarter of 1988). This request was made so that there would be a record of the fault level according to the procedures in place at the time of the event. This is required to determine Ontario Hydro's ability to run the station within its established limits.

AECB staff concludes that the Bruce NGS"B" 1988 quarterly reports comprehensively and accurately record the 1988 station performance.

3.3 Radiation Protection

There were no doses in excess of regulatory limits during 1988 although there were two cases of unplanned tritium uptakes. In one case, as described in Significant Event Report 88-34 (SER-88-34), the Ontario Hydro administrative limit of 2 mSv was exceeded.

The total whole body dose for the year was 1.58 person-Sv. This figure is reasonably close to Ontario Hydro's target when changes to the scheduled work are taken into account.

3.4 Station Effluents and Environmental Monitoring

Airborne and waterborne emissions were all well below one percent of the derived emission limits during 1988. The Ontario Hydro Assessment of Environmental Radiological Data for 1988 concludes that the dose to the critical group due to the operation of BNPD is 0.22% of the legal limit.

3.5 Process Systems

On June 19, 1988 two separate incidents occurred in which a shutdown system operated when the Reactor Regulating System (RRS) was unable to control a large spatial flux tilt. The incidents are described in SER's 88-24 and 88-26. In both cases the reactor tripped while the operators tried to maintain simultaneously a power level high enough to avoid a xenon poison-out and a power level low enough to maintain sufficient margin from the trip setpoints. AECB staff questioned Ontario Hydro on the adequacy of trip coverage for this type of situation. In addition, AECB staff were dissatisfied with the performance of the operators in permitting the transient to develop to the point where automatic action by a shutdown system was necessary. Because it claims that the operators were always in control of the reactors during the events, Ontario Hydro

classified these as Type C* process system faults. The discussion of these events continues and there are still outstanding commitments made by Ontario Hydro to review and revise operating manuals/procedures as necessary so that clear instructions exist for this type of situation.

In December, Ontario Hydro was returning Unit 7 to power following a maintenance outage when it reported problems with restricted flow paths in the annulus gas system which reduced the capability to detect incipient pressure tube failure. AECB staff then requested Ontario Hydro to shut the reactor down (as recorded in SER 88-68). Approval was given to restart the reactor after some of the blockages were cleared and extra "beetles" (moisture detection devices) were installed so that leak detection could still be effective for all pressure tubes.

On 88-10-15 a through wall crack in a unit 7 main steam line was discovered. The reactor was immediately shut down (see SER 88-45). AECB staff considers that station management acted promptly and effectively, in the interests of safety, in this event. It was determined that the crack was caused by fatigue failure due to high strain energy transmitted to the pipe through a welded lug during weekly testing of main stop valves. The section of pipe was replaced and the reactor restarted. The source of the strain energy was eliminated by removal of some structural steel guides.

During a vault survey following a Unit 5 shutdown, a D_2O leak was discovered at a heat transport system bleed valve (see SER 88-51). Subsequent radiography revealed significant metal loss in the valve body resulting in a through wall hole. This initiated an inspection and repair program for all the bleed valves in the station. This program has been completed. Analysis has determined that the amount of valve damage was related to the length of time that commissioning trim was in place in the valve so that it is believed that further erosion during normal operation should not occur.

On 88-11-07 damage to the south west extension catenary assembly occurred when the trolley was driven away from under the reactor with the west fueling machine head attached to the reactor bridge (see SER 88-54). This event revealed weaknesses in protective computer software, turnover procedures, the use of automatic equipment operation, and the use of bypass key operations. It was a potentially serious event that illustrated poor human performance but the station management follow-up response was good.

3.6 Performance of Special Safety Systems

All the special safety systems met the unavailability target in 1988 with the exception of shutdown system number one in Unit 7. The principal cause was 52.5 hours of unavailability due to incorrectly calibrated trip setpoints (see SER 88-27). AECB staff expressed concern about the poor use of procedures and length of time it took to discover the error. Ontario Hydro intends to improve its procedures in this area.

* A Type C process system fault is defined as a fault which raised fuel temperature, or increased the probability of it being raised, but significant fuel failures would not have occurred, even in the absence of special safety system action.

On 88-10-25, after completion of Unit 8 cobalt rod replacement and repairs to a shutoff rod, the over-poison shutdown guarantees were surrendered with the shutdown system two (SDS2) tank inlet valves closed (see SER 88-47) rendering SDS2 unavailable. This was a very serious procedural error which indicated shortcomings in both operation and management. AECB staff were dissatisfied with the lack of response to this event by station management, and so informed the station manager. Appropriate action was subsequently taken by Ontario Hydro.

3.7 Significant Events

Important significant events are discussed as parts of other sections of this report. The following discussion focuses on the events viewed as a whole.

There were a total of 71 significant events in 1988. Twenty of these were reportable under the operating licence as listed in Appendix A.

During the year there was a significant number of events which can be directly attributed to inadequate attention to procedures. Section 3.5 described an event which showed poor performance in fuel handling. Two serious errors with special safety systems were discussed in the previous section. Other examples include missing important scheduled work (SER 88-02), missed sections of operation instructions (SER 88-33), deviation from procedures (SER 88-34), doing work without authorization (SER 88-36), using the wrong procedures (SER 88-55), using unapproved procedures (SER 88-59) and performing unscheduled fueling (SER 88-62).

There were some events which high-lighted good performance. For example SER's 88-45/51 which have been discussed in Section 3.5 are cases where awareness led to early discovery of problems which could have led to very serious events. SER 88-60 describes an event where quick, correct action by an operator minimized a complete impairment of the emergency coolant injection system to a duration of a few seconds.

3.8 Quality Assurance

There was one AECB audit at Bruce NGS"B" during 1988. It concentrated in the area of fuel handling and resulted in seven Action Notices and four Recommendations. The audit concluded in an Assessment Report that the overall control of activities relating to fuel handling is good but the operations culture appears to tolerate unauthorized changes to specified requirements or instructions. The comment was made that if unchecked, the consequences could be significant. SER 88-54, discussed in Section 3.5, shows this comment to be true. Ontario Hydro have responded to the AECB Assessment Report and this response is currently being reviewed by AECB staff.

3.9 Station Maintenance

In last year's AECB review of Bruce NGS"B" operation, concerns were expressed about maintenance standards. During 1988 there were signs of improvement in this area.

First, and perhaps most important, new positions have been created which are dedicated to the maintenance function. Included in this is a maintenance superintendent in charge of mechanical, control and the newly created maintenance support group. While this organization is still new, it should have a positive long term impact on maintenance standards.

There have been other visible signs of improved maintenance. Housekeeping has, in general improved, radiation signs are now almost always up to date and Ontario Hydro has updated its field guide book. From the Appendix of Objective Measures it can be seen that more call-ups are being completed and the total number of jumpers has decreased.

There is still room for improvement. The station is still considered to be under-staffed. The number of deficiency reports could be reduced, more call-ups should be completed, and too many operating memos remain in effect for too long. Ontario Hydro is in the process of hiring and training new staff so AECB staff anticipates further improvements as time progresses.

3.10 Chemistry

Chemistry control at Bruce NGS"B" for 1988 was generally good. On average, the reactors were within the chemistry specifications about 90% of the time.

There were two chemistry activities which bear further discussion. First was the initiation of investigations into the causes of higher than anticipated cobalt 60 radiation fields at the reactor face. There are strong suspicions that oxidizing conditions exist in the heat transport system. Investigations thus far have included studies of end shield plugs and fuel for colour changes. More definitive investigation will continue with the installation of a special D_2O sampling system to be installed in 1989.

The second activity was the implementation of start-up hold points. This allows for much better chemistry control in the boiler secondary side and subsequently much "cleaner" boilers when full power is reached. This should result in long term benefits to boiler operation and is a practice which will be adopted across Ontario Hydro.

3.11 Station Management

On 88-03-30, Mr. R.W. Pockett was authorized as Technical Manager of Bruce NGS"B". He has previous experiences as a shift supervisor at Bruce NGS"A" and as production manager at NPD, Rolphton.

In general AECB staff were satisfied with the manner in which Bruce NGS"B" was managed in 1988. There were good efforts by the management team to track performance indicators and reduce backlogged work.

AECB staff was initially dissatisfied with the slow management response to the event in which shutdown guarantees were removed with shutdown system two injection tanks valves closed (see Section 3.6).

3.12 Training

Bruce NGS"B" staff who wrote AECB set examinations in 1988 achieved clear passes at a rate of 62%, conditional passes at a rate of 28%, and failures at a rate of 10%. AECB staff consider these results to be indicative of an acceptable training program at Bruce NGS"B".

Ontario Hydro is developing a program for continuation training for authorized personnel (Reactor First Operators, Shift Supervisors and Shift Operating Supervisors). AECB staff is of the opinion that this process should be accelerated.

3.13 Emergency Exercises and Drills

Ontario Hydro completed most of the drills targeted for 1988. It did not complete the targeted number of toxic gas release drills, but Ontario Hydro has completed its program to supply respirators and drills will be conducted on their use.

A summary of drills and exercises performed follows:

13	Emergency Drills
31	Off Site Emergency Practices/Meeting
6	Emergency Exercises (BNGS"A" incident station)

Radiation Emergency Procedures were revised during 1988. AECB staff is, in general, satisfied with Ontario Hydro's performance of drills and exercises during 1988 but considers that an improvement should be made in completing toxic gas drill requirements.

3.14 Security

There were no security incidents at Bruce NGS"B" during 1988.

In last year's annual report mention was made of the fact that Ontario Hydro had not as yet committed to a schedule of security exercises. This was done in 1988 and two intrusion exercises were held over the course of the year. AECB staff considers security to be satisfactory at the station.

3.15 AECB Staff Inspections

There were few significant deficiencies found during AECB staff inspections during 1988. There does appear, however, to be a need for Ontario Hydro to pay more attention to the contaminated exhaust filters. On occasion the filters were found in need of changing, and dampers and handswitches in the wrong positions. There were also a number of leaks noted in low pressure service water valves.

3.16 Measures of Station Performance

Measures of station performance are tables in the Appendix. Many of these indicators have been discussed as parts of other sections. This section comments on those items which were noted as "needing action" in the Appendix and as yet have not been discussed.

The call-up completion rate still needs to be improved at Bruce NGS"B". This has improved over the past year but Ontario Hydro should do better still. The same applies to the number of jumpers in effect.

Ontario Hydro seems to have made little or no progress with the administration aspect of operating memos. About half are relatively old and many systems have more than one associated memo.

Action is required in these areas.

4. SIGNIFICANT LICENSING MATTERS AND ACTIVITIES

4.1 Containment Test

As required by the licence, Ontario Hydro completed a containment leakage rate test during 1988. At the worst case accident pressure, the leakage rate was .45% of containment volume per hour. This was within the acceptable operating limit of 1% of containment volume per hour.

4.2 EFADS Commissioning

EFADS (Emergency Filtered Air Discharge System) commissioning progressed during 1988 and the system was declared "in-service" during the first week of 1989. Some questions concerning design deficiencies and the use of EFADS are still to be resolved and discussions between Ontario Hydro and AECB staff continue.

4.3 Station Complement

As reported in the 1987 Annual Report, Ontario Hydro did not, in that year, fully comply with licence condition A.A.3ii) which concerns the station staff complement. As requested by AECB staff, the process of ensuring station staff complement was formalized during 1988 into a station policy which is now being followed.

4.4 Station Organization

On 88-11-11, Ontario Hydro submitted for AECB approval (as per licence condition A.A.3), a new station staff organization. Approval was granted, with the exception of the requested reduction in the number of persons assigned to the Quality Assurance section. Discussions on this matter are still ongoing.

4.5 Moderator Pipe Break Assessment

On 88-09-16, AECB staff were informed that Ontario Hydro is conducting a moderator pipe break assessment for Bruce NGS"B". The concern is that a reduction in moderator level may induce a top-to-bottom flux tilt. With the reactor power being maintained by the regulating system, such a flux tilt could cause fuel dryout in some lower channels. There may be a requirement for new shutdown system trips to protect against this event.

5. CONCLUSIONS

In general, Bruce NGS"B" was operated safely by Ontario Hydro during 1988. There is, however, cause for concern created by the significant human performance errors observed in 1988.

Ontario Hydro should also develop a culture that places more emphasis on adherence to procedures.

Ontario Hydro still needs to improve further in the administration of jumpers, operating memos, and call-ups.

APPENDIX A

REPORTABLE SIGNIFICANT EVENTS

Report Number	Licence Condition	Event Title
88-02	A.A.19 i)	Loss of Cooling Water Due to Frazil Ice
88-03	A.A.20	Tritium Uptake Exceeding Administrative Limit
88-10	A.A.19 vii)	Apparent Level 1 Impairment of Containment
88-19	A.A.19 vii)	Airlock 2 Seal Leak Rate Test Failure Resulting in a Level 2 Impairment of NPC
88-24	A.A.19 vi)	Reactor Trip and Poison Out Caused by Flux Tilt
88-26	A.A.19 vii)	SDS1 Trip on High NOPs on Channels D and E
88-27	A.A.6	Incorrect Values Calibrated into SDS1 Trip Setpoints
88-30	ROL 11/87 A.A.19 ix)	Violation of Radioactive Transportation Licence and Conditions
88-33	A.A.19 i)	Moderator Level Reduction Due to Incorrect Valving
88-34	A.A.20	Unplanned Tritium Uptake
88-45	A.A.19 i)	Shutdown Due to Main Steam Line Crack
88-47	A.A.19 vii)	Surrender of Overpoison Condition Guarantee with SDS2 Unavailable
88-51	A.A.19 i)	Loss of Production: Delayed Unit Start-up Due to Leak in HT Bleed Valve CV6
88-52	A.A.19 i)	Loss of Production: Delayed Unit Start-up Due to Metal Loss in HT Bleed Valve CV6
88-55	A.A.19 ii)	Delay in Unit Start-up - Incorrect Weld Procedures
88-58	A.A.10 & 12	Failure to Comply with an AECB Request
88-60	A.A.19 ii)	Emergency Cooling Injection System Level 1 Impairment
88-62	A.A.19 i)	Unscheduled 8 Bundle Push
88-69	A.A.19 ii)	Moderator Temperature Excursion
88-70	A.A.20	Near Miss Radiation Incident

OBJECTIVE MEASURES OF STATION PERFORMANCE - 1988

	LAST YEAR'S VALUE		ACCEPTABLE	NEEDS ACTION
1. Radiation Control				
1.1 Occupational Safety				
1.1.1 Total Whole Body Dose 1.58 man-Sv (158 man-rem)	1.41	(141)	X	
1.1.2 Total Extremity Dose 2.73 Sv (273 rem)	1.68	(168)	X	
1.1.3 Total F/H Extremity Dose .683 Sv (68.3 rem)	.665	(66.5)	X	
1.1.4 Total Neutron Dose 1.2 mSv (.12 rem)	2.39	(.239)	X	
1.1.5 Number of Exposures > Regulatory Limits 0	0		X	
1.1.6 Number of Radiation related supervisor's investigations 12	26		X	
1.2 Public Safety				
1.2.1 Releases from the Station				
a) Airborne				
Tritium No of weeks >1% DEL 0	0		X	
Average % DEL for year .079%	.076		X	
Noble Gas No of weeks >1% DEL 0	0		X	
Average % DEL for year .038%	.031		X	
Iodine 131 No of weeks >1% DEL 0	0		X	
Average % DEL for year .0016%	.0028		X	
Particulates No of weeks >1% DEL 0	0		X	
Average % DEL for year .0032%	.0031		X	

1.2.1 Continued

	LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
b) Waterborne			
Tritium No of months >1% DEL 0	0	X	
Average % DEL for year .051 %	.021	X	
Gross β No of months >1% DEL 0	0	X	
Average % DEL for year .029 %	.011		
c) Total Heavy Water Loss 19366 kg (if excessive, should be reflected in higher tritium releases)	19773	X	
1.2.2 Environmental Measurements			
Average Boundary dose rate 55 nGy/h (5.5 μR/h) (Acceptable if within range of provincial reference sites value and not a significant increase from previous years)	54 nGy/h	X	
Average Boundary Tritium in Air .044 %MPCa (> .1% MPCa would indicate a marked increase and would require investigation)	0.48	X	
Average Tritium Concentration in Precipitation (average of all measurement sites) (+) 440 Bq/l (11.9 nCi/l)	311 (8.4)	X	
Average Gross β in Precipitation (+) 28 $MBq.km^{-2}.months^{-1}$ (0.76 $mCi.km^{-2}.month^{-1}$)	28 (.75)	X	
Average Tritium in Milk (+) 18 Bq/l (500 pCi/l)	27 (733)	X	

1.2.2 Continued

	LAST YEAR'S VALUE		ACCEPTABLE	NEEDS ACTION
Average C14 in Milk (+) 240 Bq/kg of C (6.5 pCi/g of C)	233	(6.3)	[X]	[ ]
Average I131 in Milk (+) 141 Bq/l (3.8 pCi/l)	141	(3.8)	[X]	[ ]
Average Tritium in drinking water (+) 26 kBq/l (715 pCi/l)	31	(836)	[X]	[ ]
Average gross β in drinking water (+) 85 Bq/l (2.3 pCi/l)	63	(1.7)	[X]	[ ]
Local water and fish samples (++)			[X]	[ ]

Specific items for comment:

None

Terrestrial Samples (++) [X] [ ]

Specific items for comment:

None

Notes: (+) - marked increase from previous acceptable levels warrants investigation
(++) - review in detail and identify any specific problems

2. Plant Control

		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
2.1	Number of Completed Reactor Trips/Unit 2	1.25	[X]	[ ]
2.2	Number of Serious Process Failures/Unit 0	0	[X]	[ ]

2.3 Special Safety System Unavailability (10^{-3} Years/Year)

	This Year					Last Year						
	U0	U5	U6	U7	U8	U0	U5	U6	U7	U8	ACCEPTABLE	NEEDS ACTION
SDS1		0	0	6.6	0		0	0	0	0	[ ]	[X]
SDS2		0	0	0.6	0.6		0	0	0	0	[X]	[ ]
Containment		0	0	0	0		.31	.31	.31	.31	[X]	[ ]
ECI		<0.1	<0.1	<0.1	<0.9		.39	.02	.02	.02	[X]	[ ]

2.4	Number of Reportable Incidents/Unit	5	3.25	[X]	[ ]
2.5	Number of fires	2	10	[X]	[ ]
2.6	Number of Significant Human errors reported	16	20	[X]	[ ]

3. Plant Maintenance		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
3.1 Number of Call-ups (C1,K1,M1) Outstanding at end year	235	N/A	☐	☒
3.2 Average of Monthly DRs Outstanding/Unit	1200	1200	☐	☒
4. Plant Administration				
4.1 Documentation				
4.1.1 Average No. of Op Memos in force/unit on 31 December	65	386 (total)	☐	☒
4.1.2 No. memos extant > 6 months	30/unit (50%)	35 (unit)	☐	☒
4.1.3 No. of systems (USI) with >1 Op. Memo Extant	10/unit	12 (unit)	☐	☒
4.1.4 No of Operating Memos behind schedule for review	7/unit	6 (unit)	☐	☒
4.2 Training				
4.2.1 % Scheduled drills completed	100% (except for toxic gas drills)	94%	☐	☒
4.2.2 % Candidates passing AECB exams	90%	86%	☒	☐

		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
4.3 Security				
4.3.1 Number of reportable security events	0	4	☒	☐
4.4 Quality Assurance				
4.4.1 Results of AECB Audits				
1) Date	June 21 - 24		☒	☐
2) Date			☐	☐
3) Date			☐	☐
4.4.2 AECB Assessment of Station Quality Assurance Manual *			☐	☐

* under review